Experimental investigation of gas-oil-water phase flow in vertical pipes: influence of gas injection on the total pressure gradient

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Abstract

Experimental work has been conducted to study the influence of gas injection on the phase inversion between oil and water flowing in a vertical pipe. A vertical transparent pipe test section line of 40 mm ID and 50 cm length was used. The test fluids used were synthetic oil and filtered tap water. Measurements were taken for mixture velocity, superficial water velocity, superficial gas velocity, and input superficial oil velocity ranging from 0.4 to 3 m/s, 0.18 to 2 m/s, 0 to 0.9 m/s, and 0 to 1.1 m/s. Most of the experiments were conducted more than two times, and the reproducibility of the experiments was quite good. Special attention was given to the effect of oil and water concentration where phase inversion took place with and without gas injection. The results showed that the phase inversion point was close to water fraction of similar to 30%, for both water friction direction changes (from water to oil or from oil to water) and that the effective viscosity increases once the mixture velocity increases. On the other hand, the results with gas injection showed that gas injection had no effect on the oil or water concentration where phase inversion occurred. Furthermore, the study investigated the effect of gas-oil-water superficial velocity on the total pressure gradient in the vertical pipe. It was found that the total pressure gradient was fast and increased at high superficial gas velocity but was slow at low superficial gas velocity. When the superficial oil velocity increased, the total pressure gradient approached the pressure gradient of an oil-water two-phase flow. The obtained results were compared with few correlations found in the literature, and the comparison showed that the uncertainty of the flow pattern transition peak in this study is very low.

Keywords

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KeyWords Plus: LIFT; OPTIMIZATION; INVERSION; FIELD

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